EPA Region 5 Records Ctr.

325107

REFERENCE: 51

IDEM. Standard Operation Procedures, Grab Groundwater Sampling from Boreholes

December 13, 2007. 22 pages

IDEM	**Grab Groundwater Sampling from Boreholes** **P-004-OLQ-X-XX-07-S-R0** **Standard Operating Procedure** **Office: Land Quality** **Branches: Remediation Services and Science Services** **Sections: All Remediation Services and Services Sections** **Revised:** ***N/A*** **Revision Cycle:** ***Every 2 years*** **Effective date: November 30, 2007**

Scope of Operations

At sites where contaminated soil is in contact with groundwater, or groundwater contamination appears likely, an initial screening-level groundwater contamination assessment is acceptable. The objectives of the screening assessment are to determine whether groundwater is (likely to be) contaminated, and whether the impacted hydrogeologic unit is considered an aquifer. Grab groundwater samples can be collected from direct-push probes or temporary monitoring wells (installed with push-probe technology or hollow stem augers, etc.) taking note of the vertical interval sampled. Grab groundwater samples may be collected from a sufficient number of points to document contaminant concentrations horizontally and, if necessary, vertically.

Discrete-depth, direct-push (Geoprobe) groundwater samplers are used during initial site investigations to provide preliminary information on the degree and extent of groundwater contamination. This information, along with subsurface stratigraphic data, can assist with determining the appropriate number, location and screening of permanent monitoring wells.

This Standard Operating Procedure (SOP) outlines the collection of grab groundwater samples from boreholes as it relates to the Quality Assurance Project Plan (QAPP). This SOP is limited to the actual sample collection only and does not cover Access Agreements, Sample Request Sheet Sign-Off, Contract Laboratory, Set-Up, Field Documentation, Sample Shipping, Underground Utility Clearance procedures, and Data Verification and Validation, which are under separate individual SOPs.

Scope of Applicability

This SOP applies to all OLQ Remediation Services and Science Services staff who will be collecting grab groundwater samples from boreholes during field sampling events at remediation program sites.

The groundwater sample collection procedures in this SOP are applicable to IDEM's Site Investigation Program. However, personnel in that program utilize the U.S. Environmental Protection Agency's (EPA) Contract Laboratory Program (CLP) which has its' own sample request, documentation, chain-of-custody, and shipping requirements. When utilizing the EPA CLP, follow the Site investigation Program SOPs which are identified individually in the References section.

Authorized Signatures

I approve and authorize this Standard Operating Procedure:

Section QA Contact(s)

John Clark	[signature]	11/19/07
Typed/ Printed	Signed	Date
Fran Metcalfe	[signature]	11/19/07
Typed/ Printed	Signed	Date

Section Chief(s)

Larry Studebaker	[signature]	11/19/07
Typed/ Printed	Signed	Date
Steve Buckel	[signature]	11/19/07
Typed/ Printed	Signed	Date

Branch QA Coordinator, Science Services

David Harrison	[signature]	11/30/07
Typed/ Printed	Signed	Date

Branch Chief, Science Services

Laura Steadham	[signature]	2 DEC 2007
Typed/ Printed	Signed	Date

Branch Chief, Remediation Services

Bruce Oertel	[signature]	12 5-07
Typed/ Printed	Signed	Date

Branch QA Coordinator, Remediation Services

Nancy Dollar	[signature]	5 Dec 2007
Typed/ Printed	Signed	Date

OLQ Assistant Commissioner

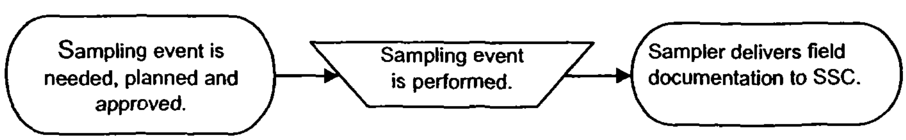
Bruce Palin — Bruce Palin — 12/10/07
Typed/ Printed — Signed — Date

Quality Assurance Manager
This Standard Operating Procedure is consistent with agency requirements.

Lowell Jackson — 12-13-07
Indiana Department of Environmental Management — Date
Quality Assurance Program
Planning and Assessment

Table of Contents

1. Overview work flow chart



2. Definitions

Agency: The Indiana Department of Environmental Management

Assistant Commissioner (AC): An Assistant Commissioner with the Indiana Department of Environmental Management.

Authorized – Established by official authority and usage; as with a policy, standard operating procedure (SOP), or quality assurance project plan (QAPP) that is signed and dated.

Branch Chief (BC): A management level position in one of the Program Area branches in the Agency.

Chemistry Gatekeeper (CG): The person in Chemistry Section of OLQ that is the site Chemist (If there is one), or any Environmental Chemist 1 (EnvChem1)

Environmental Chemist (EC): Staff level position within the chemistry section.

Environmental Samples: Any media taken from a specific location that will be analyzed by a laboratory.

Geological Services Section: The section of geologists in the Science Services Branch (SSB) of the

Office of Land Quality (OLQ).

Geoprobe™ Model 6620 with Screen Point 15/16 Groundwater Samplers: Hydraulic push-probe machine with sealed-screen sampler used to collect grab groundwater samples at variable depths.

Geologist: One versed in geology or engaged in geological study or investigation.

Grab Groundwater Sample: a given volume of water discharge collected at a discrete depth at a single point-in-time for screening of contaminant conditions.

Laboratory: The facility authorized by the Indiana Department of Administration or the Indiana Department of Health (ISDH) that performs the analysis of environmental samples for the Office of Land Quality.

Office of Land Quality (OLQ): One of the major departments within the Indiana Department of Environmental Management (IDEM).

Operator: An individual trained in the operation of Geoprobe™ hydraulic push-probe machine. Operator may be both the sampler and operator depending on training, capabilities, and sampling duties and requirements.

Program Area: The OLQ program areas supported by the Science Services Branch for this SOP include, but are not limited to, the Leaking Underground Storage Tank (LUST) Program, the Excess Liability Trust Fund Program, the State Cleanup Program, the Indiana Brownfields Program, the Federal Programs, the Site Assessment Program, the Voluntary Remediation Program.

Project Manager (PM): (1) Person who coordinates, oversees, and makes technical recommendations with regard to work that includes the collection, use, or reporting of environmental data. For the purposes of IDEM, the work may involve activities such as permitting, monitoring, investigation, or remediation. (2) IDEM representative needing a procurement for outside services to complete a specified task. (3) The individual responsible for the general oversight of projects.

Quality Assurance Project Plan (QAPP): A document describing in comprehensive detail the necessary quality assurance, quality control, and other technical activities to ensure that the results of the work performed will satisfy the stated performance criteria. Quality Assurance Project Plans commonly apply to data gathering activities associated with projects and lab procedures. QAPPs are commonly needed for remediation projects, and mitigation projects. QAPPs may contain one or more standard operating procedures.

Quality Assurance (QA): An integrated system of management activities involving planning, implementation, documentation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client.

Quality Assurance Officer (QAO): The person in the Science Services Branch of OLQ responsible for ensuring that QA criteria are met.

Quality Control (QC): The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality. In other words, QC involves measuring the "thing produced" against a standard to ensure it is a quality product that meets the identified need. **Sample Field Sheet (SFS):** The required document identifying a specific sample location during a field sampling event.

Sample Field Sheet (SFS): The required document identifying a specific sample location during a field sampling event.

Sample Request Sheet (SRS): A required document, which is provided to the SSC, requesting that a sampling event be set up.

Sample Set-Up Chemist (SSC): The person in the Chemistry Section of OLQ who provides coordination of the sampling event between the project manager and ISDH or contract laboratory.

Sampler: Individual responsible for the planning, collection, and documentation of the sampling event.

Sampling Equipment: Various devices used to collect samples as described in USEPA documentation.

Sampling Event: The occasion in which environmental samples (soil, sediment, water, etc.) are collected and submitted to a laboratory for analysis.

Science Services Branch (SSB): The program area within the Office of Land Quality (OLQ) responsible for scientific related technical services.

Section Chief (SC): A first-level Agency supervisor responsible for managing non-supervisory Agency staff.

Site Information Sheet (SIS): The required document identifying general information (site name, site number, sample numbers, weather conditions, field equipment, types of samples, etc.) that provides an overview of the field sampling event.

Technical Staff: Positions within the OLQ Science Services Branch that require specialized knowledge pertaining to a particular occupation or field of study such as Chemistry, Geology, Engineering, and Risk Assessment.

3. Roles

Role Title
Chemistry Gatekeeper (An Environmental Chemist (EC))
Sample Set-up Chemist ((SSC) An assigned EC)
Environmental Chemist Supervisor (ECS)
Project Manager (PM)
Sampler/Operator
Technical Staff (TS)
Section Chief (SC)
Branch Chief (BC)
Assistant Commissioner (AC)

Responsibilities:
Chemistry Gatekeeper (CG): Responsible for ensuring that the sample request sheet is technically adequate to meet the project objective. The Chemistry Gatekeeper is to provide technical assistance and recommendations for the following: sampling goal/purpose, sample type, number of samples, collection methods, locations, analytical parameters and methods, and any other special considerations.

Sample Set-up Chemist (SSC): Responsible for determining the estimated laboratory cost of the requested sampling and analysis event and makes arrangements with the laboratory for analytical services.

Operator: Person who operates the Geoprobe™ hydraulic push-probe machine. Operator may be both the sampler and operator depending on training, capabilities, and sampling duties and requirements.

Project Manager (PM): Person who determines if a sampling event is necessary and develops the *Site Specific Work Plan* (or equivalent sampling plan documentation) and *Health and Safety Plan*. The PM then coordinates the sampling event by filling out and acquiring the appropriate signatures, acquiring access agreements, contacting residents, organizing a sampling team, overseeing, and/or collecting the samples at the site in order to make site decisions.

Sampler: Project manager or designee who collects grab groundwater sample(s) utilizing the hydraulic push-probe machine. Person may be both sampler and operator depending on training, capabilities, and sampling duties and requirements.

Technical Staff (TS): Refers to all Chemists and Geologists in the OLQ Science Services Branch (SSB) who may participate in the sampling effort, as appropriate.

ECS, SC, BC and AC: As appropriate, the Section and/or Branch Chief(s) and/or Assistant Commissioner evaluate the SRS "Reason for Sampling" and the "Projected Cost" to make the determination for approval.

Experience requirements:

EC2: Two year full-time experience as an analytical chemist in the environmental field.
Substitution: Accredited graduate training in the above areas may substitute for the required experience on a year for year basis. Working knowledge of program requirements and sampling protocols.
EC1: Four year full-time experience as an analytical chemist in the environmental field.
Substitution: Accredited graduate training in the above areas may substitute for the required experience on a year for year basis. Working knowledge of program requirements and sampling protocols.
ECS: Five (5) years full-time professional experience as an analytical chemist. At least two (2) years of the above experience must be in an administrative, leadership, managerial or supervisory capacity. Working knowledge of program requirements and sampling protocols.
Geologist: Working knowledge of program requirements and sampling protocols.
Operator: Working knowledge of Geoprobe™ operation, program requirements, and sampling protocols.
PM: Working knowledge of program requirements and sampling protocols.
Sampler: Working knowledge of program requirements and sampling protocols.
SC(s), BC(s) and AC(s): Full-time professional experience in an environmental or environmental public health field; or related field; or related experience. Specified minimal years of the required experience must be in an administrative, leadership, managerial, or supervisory capacity.

Qualifications and Training requirements:
EC2: *Graduation from an accredited college/university plus years of experience.* (*Major in* CHEMISTRY required.)
EC1: Graduation from an accredited college/university plus years of experience, and attendance at mandatory internal sampling training. (Major in CHEMISTRY required.)
ECS: Graduation from an accredited college/university plus years of experience, and attendance at mandatory internal sampling training. (Major in CHEMISTRY required.)
Geologist: Graduation from an accredited college/university plus years of experience in geology/hydrogeology (Major in GEOLOGY required), and attendance at mandatory internal sampling training.
Operator: Training and competence in operation of Geoprobe™ hydraulic push-probe machine, and attendance at mandatory internal sampling training.
PM: Full-time professional experience with 5 years in an environmental or environmental public health field or related experience, and attendance at mandatory internal sampling training.
Sampler: Professional experience and attendance at mandatory internal sampling training.
SC(s), BC(s) and AC(s): Full-time professional experience in an environmental or environmental public health field; or related field; or related experience. Specified minimal years of the required experience must be in an administrative, leadership, managerial, or supervisory capacity.

4. Description of equipment, forms, and/or software to be used

Direct-Push Technology (DPT) grab sampling tools or devices are used to rapidly collect samples to define groundwater conditions during one sampling event. Point-in-time sampling tools are typically used during site characterization to identify plume boundaries, hot spots, preferential pathways, or other monitoring points of interest. They cannot be used for long-term monitoring or trend analysis since the boreholes need to be decommissioned upon completion of sampling. The time needed to retrieve the sample will vary according to the hydraulic conductivity of the sampling zone. In general, sampling within coarse-grained sediments take minutes while fine-grained sediments may take several hours or more.

4.1 General Equipment
· Water-level indicator
· Logbook
· Writing pen w/ indelible ink
· Calculator
· Field-data sheets
· Chain of custody records and seals
· Copy of site-specific QAPP *Work Plan* and *Health and Safety Plan* (HASP)
· Sample containers and labels
· Preservatives
· Sharp knife (locking blade)
· Adjustable wrench
· Pipe Wrenches
· Appropriate personal protection equipment (gloves, safety shoes, and eye wear at a minimum, hard hat if overhead hazard)
· Protective gloves (examples: rubber, latex or nitrile)
· Five-gallon pails or larger tubs
· Plastic sheeting
· Shipping containers/coolers
· Ice or other coolant
· Packing materials
· Ziplock-type plastic bags
· Non-phosphate soap
· Tap water, distilled or deionized water for decontamination (decon) solutions
· Several brushes

4.2 Sampling Extraction Equipment and Materials

Geoprobe™ Model 6620 with Screen Point 15/16 Groundwater Samplers

This sealed-screen sampler consists of a short screen nested within a sealed, water-tight tool body. Because the screen is not exposed to the formation as the sampler is advanced into the subsurface, the screen does not become plugged or damaged. While the sampler is at depth, O-ring seals at each rod joint, the drive head, and the expendable drive point provide a watertight system. The potential for cross contamination is greatly reduced and a true depth-discrete sample that is representative of the target sampling zone can be collected. Multi-level sampling in a single borehole can be accomplished with the Geoprobe™ by retrieving the sampler and decontaminating it or replacing it with a clean sampler before reentering the hole to collect another sample.

Geoprobe™ Tools
· Probe rods, 1.25-inch OD or 1.5-inch OD
· Drive cap
· Pull cap
· O-rings
· Extension rods
· Extension rod coupler
· Extension rod handle
· Extension rod jig
· Quick link extension rod connectors
· Rod grip pull system/handles

Screen Point 15/16 Groundwater Sampler Parts and Accessories
· Sampler sheath
· Drive head
· O-ring service kit
· Screen Point sampler kit for 1.25-inch or 1.5-inch probe rods
· Screen push adaptor

· Grout plug push adaptor
· Grout nozzle
· Grout plugs, PVC
· Expendable drive point, steel and aluminum

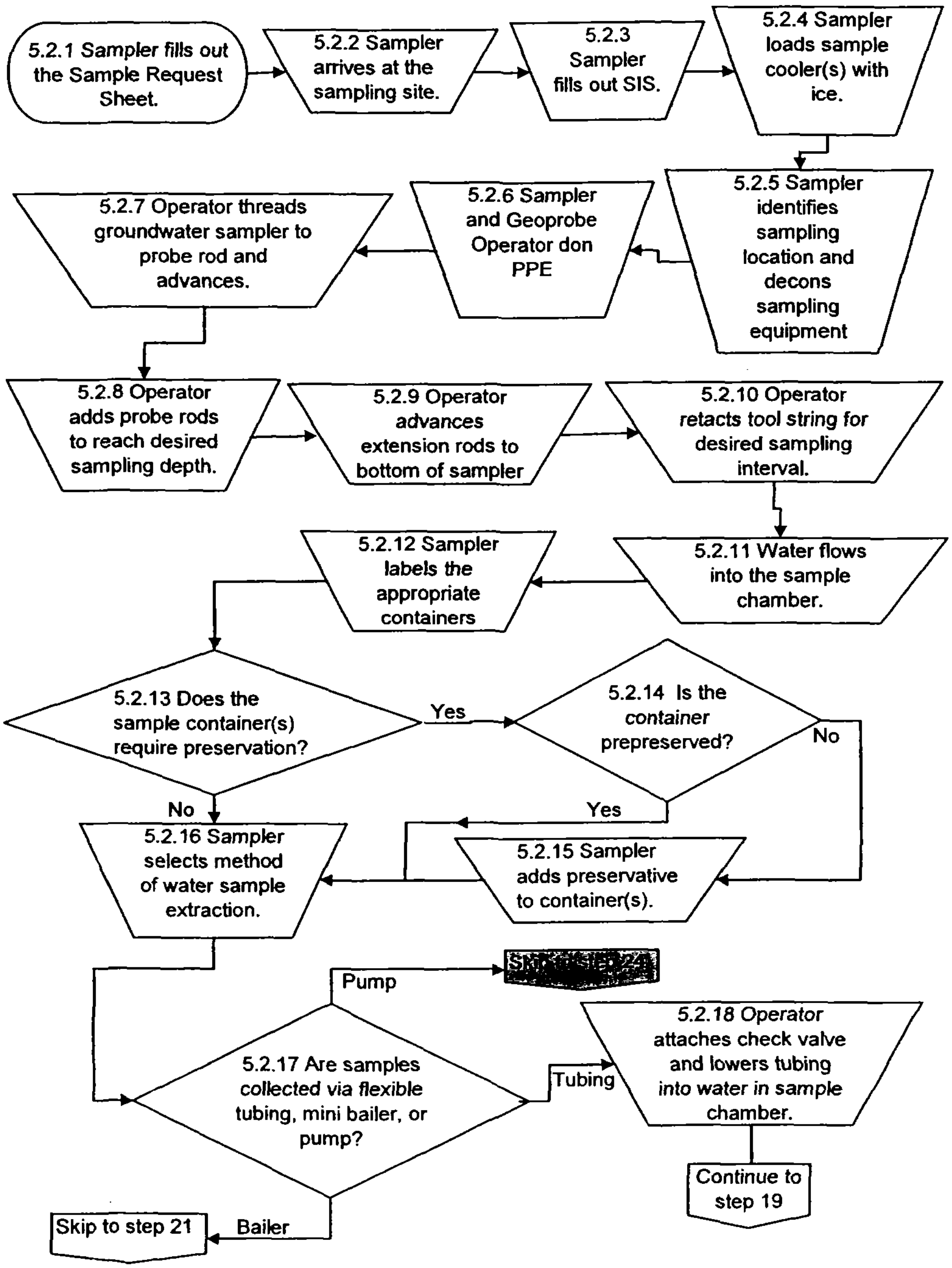
Sample Extraction Equipment
· Flexible tubing
· Stainless steel mini-bailer
· Vacuum pump
· Peristaltic pump
· Pneumatic bladder pump

4.3 Sheets/Forms
· Sample Request Sheet
· Site Information Sheet
· Sample Field Sheets
· Chain-of-Custody Form

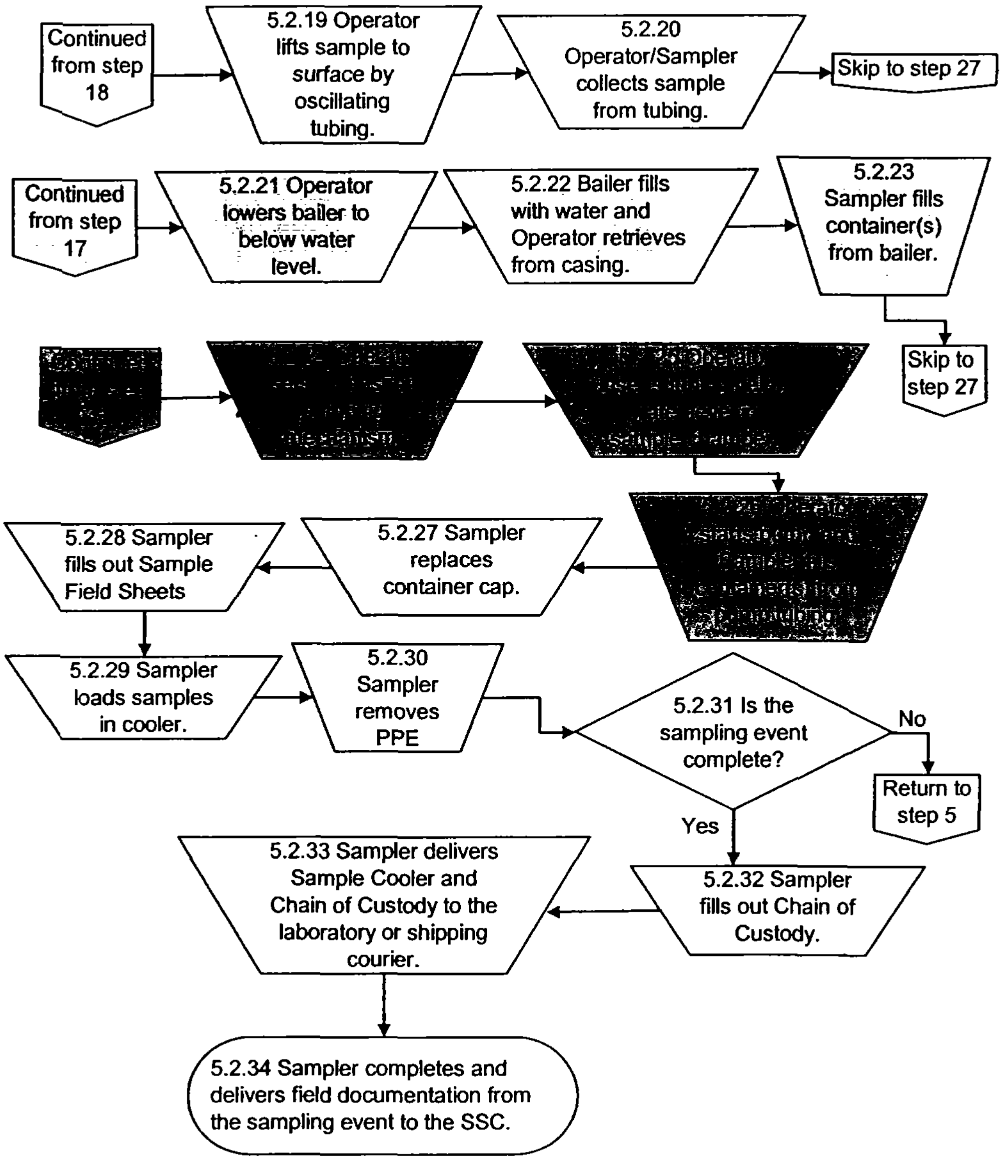
4.4 Software
· E-mail
· Microsoft Word
· Microsoft Excel

5. Procedure

5.1 Procedural Flowchart



0010


Continued from step 18
5.2.19 Operator lifts sample to surface by oscillating tubing.
5.2.20 Operator/Sampler collects sample from tubing.
Skip to step 27
Continued from step 17
5.2.21 Operator lowers bailer to below water level.
5.2.22 Bailer fills with water and Operator retrieves from casing.
5.2.23 Sampler fills container(s) from bailer.
Skip to step 27
5.2.28 Sampler fills out Sample Field Sheets
5.2.27 Sampler replaces container cap.
5.2.29 Sampler loads samples in cooler.
5.2.30 Sampler removes PPE
5.2.31 Is the sampling event complete?
No
Return to step 5
Yes
5.2.33 Sampler delivers Sample Cooler and Chain of Custody to the laboratory or shipping courier.
5.2.32 Sampler fills out Chain of Custody.
5.2.34 Sampler completes and delivers field documentation from the sampling event to the SSC.

5.2. Procedure

1. Site Project Manager fills out the sample request sheet as described in the *Chemistry Support Sample Request Sign-Off SOP* assuring to identify all aspects relative to the appropriate QAPP (or equivalent Work Plan) sampling requirements.
2. Sampling team arrives at the sampling site with sufficient ice for the sampling cooler(s).
3. Sampler fills out Site Information Sheet (SIS) and Sample Field Sheets as described in the *Chemistry Support Field Documentation SOP*.
4. Sampler loads sample cooler(s) with ice to refrigerate samples as they are collected. It is recommended to use a 3:1 ration of ice to sample containers. Ice may be enclosed in zip-lock type bags and evenly distributed among the sample containers as they are collected.
5. Sampler confirms the appropriate sample collection location and performs the decontamination of sampling equipment, utilizing the appropriate QAPP or equivalent Work Plan.
6. Sampler/Geoprobe™ Operator don Personal Protection Equipment (PPE) as described in the site-specific *Health and Safety Plan*.
7. Sampler/Operator threads assembled Screen Point 15/16 Groundwater Sampler onto the leading end of a Geoprobe™ direct-push machine.
8. Sampler/Operator incrementally adds additional probe rods and advances the tool string until the desired sampling depth is reached.
9. Sampler/Operator advances extension rods downhole until leading rod contacts the bottom of the sampler.
10. Sampler/Operator retracts tool string a distance equal to the length of the desired sampling interval while the screen is held in place with the extension rods and the expendable point is released from the sampler sheath.
11. Water flows through the screen under the hydraulic head conditions existing at the sampling depth and into the drive rods or sample chamber.
12. Sampler removes the parameter-specific containers from the cooler and labels the containers with permanent ink/marker.
13. Does the desired sample analysis require preservation? If yes, continue to step 14; if no, skip to step 16.
14. Is the container(s) pre-preserved? If yes, skip to step 16: if no, continue to step 15.
15. Sampler carefully adds the appropriate provided preservative to each of the parameter-specific sample containers.
16. Sampler/Operator proceeds with selected water extraction method to collect the grab groundwater sample. Note: Refer to Appendix – Supporting Procedure Considerations for sample extraction options.
17. Are the samples collected via flexible tubing, stainless steel mini-bailer, or pump? If flexible tubing, continue to 18: if stainless steel mini-bailer skip to 21: if pump skip to 24.
18. Sampler/Operator attaches check valve to one end of the polyethylene or Teflon tubing and inserts down the casing (rods) until immersed in groundwater within the sample chamber.
19. Sampler/Operator lifts water sample to the ground surface oscillating the tubing up and down.
20. Operator/Sampler collects water sample by withdrawing and draining the tubing directly into the Appropriate parameter-specific sample container(s). Skip to step 27.
21. Sampler/Operator gently lowers the stainless steel mini-bailer down the inside of the casing to below water level.
22. Sampler/Operator allows bailer to fill with water and retrieves from the casing.
23. Sampler fills sample container(s) directly from bailer. Skip to step 27.
24. Set up desired vacuum, peristaltic, or bladder pump according to manufacturer's instructions. Note: See Appendix – Supporting Procedure Considerations for turbidity and loss of volatiles considerations and sampling depth restrictions.
25. Sampler/Operator inserts appropriate tubing with vacuum, peristaltic, or bladder pump down the rod string below the water level in the sampling chamber.
26. Sampler fills sample container(s) from pump tubing.
27. Sampler replaces container cap as described in the site-specific Health and Safety Plan.
28. Sampler completes filling out the Sample Field Sheets as described in the *Chemistry Support Field Documentation SOP*.
29. Sampler immediately places the collected water sample containers in zip-lock type bag plastic storage bags, seals bags, and places the bagged sample containers in the sample cooler.

30. Sampler/Operator removes Personal Protection Equipment (PPE) as described in the site-specific Health and Safety Plan.
31. Is the sampling event complete? If yes, continue to step 32: if no, repeat steps 5-28 until sampling event is complete.
32. Sampler fills out Chain of Custody as described in the Chemistry Support Field Documentation SOP.
33. Sampler delivers sample cooler(s) and Chain of Custody to the laboratory or shipping courier (i.e. FedEX, UPS) drop point.
34. Sampler completes and delivers field documentation from the sampling event to the SSC as described in the Chemistry Support Field Documentation SOP.

6. Standards and checklists

Chemistry Support Field Documentation SOP contains documentation that is utilized to assure specific steps are completed.

Chemistry Support Sample Request Sheet Sign-Off SOP provides reference for the sampler to assure appropriate analytical parameters, media, numbers of samples are being collected.

7. Records Management

Upon completion of the verification, validation and the assessment of the data package, the verification and validation memorandum, tables, and all field documentation are attached to the data package and routed back to the PM. The original checklist(s), a copy of the field documentation, and a copy of the verification and validation memorandum are kept in the Chemistry Section. The PM forwards the completed documentation to the IDEM Central Files or the Virtual File Cabinet electronic document storage system.

8. Quality Assurance / Quality Control

Quality Assurance / Quality Control is monitored via the data verification and validation process.

9. Continuous Improvement Cycle

Triggers / Performance measures & standards

The data verification and validation process reviews the sampling documentation for any performance problems.

Triggers Response

If the same problem is documented on a routine basis, then an investigation of the cause of the problem will be initiated.

Modification procedures

The staff within Chemistry Support and Geological Services can identify a potential change. The Section QA Contacts will be notified and take appropriate action. Results of the investigation will be used to determine whether sampling practices need to be updated or sampler needs additional training.

Assessment

Changes will be assessed by monitoring the quality of the work product delivered to the peer reviewers and ECS. The Section QA Contacts will evaluate the SOP biannually to determine if aspects of the SOP are still accurate, appropriate and applicable.

10. References

Geoprobe™ Screen Point 15 and Screen Point 16 Groundwater Samplers SOP, Technical Bulletin 95-1500.

IDEM Chemistry Support Field Documentation P-004-OLQ-S-CH-07-S-RO SOP, June 5, 2007
IDEM Chemistry Support Sample Request Sheet Sign-Off M-002-OLQ-X-XX-06-S-RO SOP, June 8, 2007

IDEM Non-Rule Policy Document "Sampling and Analysis of Groundwater for Metals at Remediation Sites (Waste -0057-NPD), 3/17/05

IDEM Site Investigation Program – Documentation of Site Activities S-008-OLQ-R-SA-07-S-RO SOP, September 15, 2007

IDEM Site Investigation Program – Contract Laboratory Program Pre-Field Planning Procedure S-003-OLQ-R-SA-07-S-RO SOP, July 3, 2007

IDEM Site Investigation Program – Contract Laboratory Program FORMS II Lite S-005-OLQ-R-SA-07-S-RO SOP, July 3, 2007

IDEM Site Investigation Program – Contract Laboratory Field Procedures S-004-OLQ-R-SA-07-S-RO SOP, July 3, 2007

U.S. EPA Methods for the Determination of Organic Compounds in Drinking Water-Supplement III (EPA/600/R-95-131)

U.S. EPA Methods for the Determination of Organic Compounds in Drinking Water Supplement I (EPA/600/4-90/020

U.S. EPA Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods, SW-846, 3rd Edition

U.S. EPA Model 5400 Geoprobe™ Operation, SOP #2050, 3/27/1996

U.S. EPA GW Monitoring Well Installation Using the Geoprobe™, New England Region 1, 6/20/2002

ASTM D 6282 Standard Guide for Direct Push Soil Sampling for Environmental Site Characterizations

11. History of Revisions

Not Applicable

12. Appendix

Appendix: Supporting Procedure Considerations
- 1A: Open-Hole Sampling Methods/Limitations
- 1B: Sample Extraction Methods and Equipment
- 1C: Turbidity and Loss of Volatiles Considerations

Appendix

Supporting Procedure Considerations

1A: Open-Hole Sampling Methods/Limitations

Open-hole sampling is conducted by advancing drive rods with a drive point to the desired sampling depth. Upon reaching the sampling depth, the rods are withdrawn slightly causing separation from the drive tip and allowing water to enter the rods. The water can be sampled by lowering a bailer into the rods or by pumping. The open-hole method is only feasible with formations that are fairly cohesive, otherwise the formation may flow upwards into the rods when they are withdrawn, preventing samples from being collected.

With single rod systems, open-hole sampling can only be conducted at one depth within a borehole because the borehole cannot be flushed between sampling intervals and cross contamination can occur. Dual tube systems, on the other hand, can be used to conduct multi-level sampling.

LIMITATIONS of discrete-depth "grab" groundwater sampling devices:

1. Some designs are incapable of collecting groundwater samples at the water table surface.
2. Some devices have excessively long collection times when obtaining groundwater samples from silt or clay formations.
3. Most devices have relatively short screen lengths that may miss contamination.
4. Some devices have limited sample volume capabilities.
5. The screens of these devices may allow appreciable quantities of fines to enter the sample chamber.
6. It may be difficult, if not impossible to properly develop the borehole to collect sediment-free samples or samples representative of the surrounding groundwater quality.
7. These devices have soil type and depth limitations and are generally not capable of penetrating gravel, cobbles, hard or cemented layers and certain sands.
8. Boreholes created by these devices may be difficult to properly abandon.
9. Discrete-depth groundwater samplers cannot replace properly-constructed monitoring wells for collecting representative, high quality groundwater samples.

1B: Sample Extraction Methods and Equipment

a. Polyethylene/Teflon tubing and tubing-bottom check valve

   The check valve (with check ball) is attached to one end of the tubing and inserted down the casing until it is immersed in groundwater. Water is pumped through the tubing and to ground surface by oscillating the tubing up and down. It oscillating the tubing is undesirable (such as when sampling for volatiles analysis), lower the check valve and tubing to the bottom of the sampler without the check ball. Then drop the check ball into the tubing from the ground surface. The ball will seat in the check valve and trap the sample in the tubing. Collect the sample by withdrawing and draining the tubing.

b. Peristaltic/Vacuum Pump

   Attach a peristaltic or vacuum pump to the end of the tubing and lower down the casing until immersed in groundwater within the sampler. During extraction of the sample, this equipment may cause agitation and disturbance resulting in the loss of volatile components. This method is limited in that water can be pumped to the surface from a maximum depth of approximately 26 feet. Extract the grab groundwater sample from the tubing end at the ground surface.

c. Mini-Bailer Assembly

   The mini-bailer is lowered down the inside of the casing below the water level where it fills with water and is then retrieved from the casing. The grab groundwater sample is collected from the bailer.

d. Pneumatic Bladder Pump

This type of pump is preferred for low-flow sampling (EPA 1996). It provides minimal disturbance of the sample because fluid is pushed, not drawn or vacuumed, to the surface. Turbidity is low and loss of volatile contaminants is negligible.

1C: Turbidity and Loss of Volatiles Considerations

In groundwater sampling, turbidity generally refers to the presence of suspended particles in the sample. These particles may be entrained in the groundwater when the subsurface is disturbed by the sampling process. Sample turbidity and disturbance can cause bias as a result of the adsorption of chemicals onto, or the release of chemicals from, the surface of particles in the sample.

DPT methods that promote high turbidity levels, such as open-hole sampling or exposed-screen methods should be avoided. Loss of volatiles can be minimized by using extraction methods which push (rather than draw or vacuum) the sample to the ground surface, and by limiting rapid movement and handling of equipment throughout the sampling process.

Methods to minimize turbidity and loss of volatiles:

- Adequate quality control (QC) procedures which minimize agitation of the sample and turbulence within the casing (rods) and sampler.
- Installation of filter packs
- Developing and sampling a temporarily-installed well
- Utilize low-flow sampling methods

Missouri
Department of
Natural Resources

DRAFT

Two Tiered Approach to Determining Plume Stability

The guidance for determining plume stability explained herein applies to petroleum contaminants in groundwater. The two-tiered approach outlined here provides guidance pertaining to plume stability determinations at: 1) sites where contaminant concentrations in soil and groundwater are very low relative to target levels, and 2) all other sites having groundwater contamination. For the latter, this guidance offers an objective approach to determining plume stability through the use of modeling or statistical analysis.

The two-tiered approach provides for two different tiers of plume stability determination. The first tier is referred to as Tier 1 and pertains to sites where contaminant concentrations in groundwater are very low relative to target levels and contaminant concentrations in soil do not exceed soil type specific target levels for the leaching to groundwater pathway. The second tier is referred to as Tier 2. The Tier 2 approach is applied at all sites that do not meet the Tier 1 criteria specified herein. Both tiers require detailed and complete site characterization of both soil and groundwater before attempting to determine whether a plume is stable.

The Tier 1 process is intended to determine whether a traditional plume stability determination is necessary. The process may begin only after site characterization has been completed (as determined by the department). Site characterization includes submittal of a report to MDNR that includes data demonstrating that the vertical and horizontal extents of contamination have been defined and data that clearly identifies high and low groundwater elevations (i.e., the "smear zone"). If a site meets the objectives of the Tier 1 process (stated below), further groundwater monitoring is not required.

Sites meeting the following Tier 1 criteria need not further evaluate plume stability:

1. As determined by the department, vertical and horizontal delineation of contamination is complete.
2. All contaminant concentrations in soil (based on comparison to maximum values) are below soil type specific Leaching Values (LV), and
3. Contaminant concentrations in groundwater, measured quarterly over at least one year, do not exceed 50% of the Soil Type 1 Risk-Based Target Levels (RBTLs) for the applicable groundwater pathway having the lowest RBTL.

The following should be considered when determining whether the Tier 1 criteria have been met:

- If source removal occurs at a site having groundwater contamination, groundwater monitoring must be conducted to establish the effect of source removal on contaminant concentrations in groundwater. Such sampling should occur initially at least 90 days after remediation and continue on a quarterly basis for at least one year.
- If source removal does not occur, or if removal activities leave contaminants within the smear zone, contamination in the smear zone must be considered in relation to both current and anticipated future groundwater elevations. The evaluator must consider the effect of fluctuations in groundwater elevation on contaminant concentrations in groundwater due to

the presence of contaminants in soil within the smear zone (i.e. determine whether fluctuations in groundwater elevation will increase contaminant concentrations in groundwater). All contaminant concentrations within the defined smear zone must be considered when determining whether the Tier 1 LVs have been met.

If the above Tier 1 criteria cannot be met, plume stability must be determined through Tier 2. Tier 2 requires the following:

- groundwater samples are collected quarterly over at least 2 years
- a model and/or statistical tool be used to evaluate stability, and
- contaminant concentrations within the smear zone be identified and evaluated to determine if future groundwater elevation fluctuations could result in increases in contamination concentrations in groundwater.

The Tier 2 process is completed by meeting the following objectives:

1. Data from at least two years of quarterly groundwater monitoring has been collected.
2. Site characterization is complete, including an evaluation and analysis of the smear zone and discussion of groundwater fluctuations at the site.
3. Plume stability has been demonstrated within three years as determined by statistical analysis and/or modeling.

At least two years of quarterly groundwater monitoring is needed based on minimum data needs for meaningful statistical analysis. Evaluating plume stability is only one element of site characterization and is intended to confirm previous site characterization findings. Consequently, the plume stability determination process is predicated on full and comprehensive site characterization of both soil and groundwater. Certain site characterization elements are more meaningful than others with respect to their effect or potential effect on plume stability. Of critical importance is a detailed evaluation and analysis of the smear zone, as significant soil contamination within the zone is likely to result in increases in contaminant concentrations in groundwater as groundwater comes into contact with the soil contamination in the future. Consequential rises in groundwater elevation might or might not be observed during the two years of groundwater monitoring. In such cases, monitoring beyond two years will be necessary. If further monitoring does not represent historical high groundwater elevations, predictive analysis might be necessary to determine whether eventual increases in the groundwater elevation will result in increases in contaminant concentrations in groundwater.

As per the MRBCA guidance, if plume stability cannot be demonstrated after three years of groundwater monitoring, the plume is not stable and additional actions, be they investigative or remedial, will be required.

As above, meaningful statistical evaluations of plume stability require at least 2 years of quarterly groundwater monitoring. Most statistical tools used to determine plume stability require 8 to 10 samples per monitoring well.

The department believes that many models and statistical methods may be used to determine plume stability, as long as they are correctly applied, including using data of an appropriate quality and quantity. The department will require that the evaluator provide a copy of the model or statistical tool being used to the department, unless the department already has a copy. Both the model itself and a user manual must be provided.

Guidance Pertaining to Specific Models/Statistical Methods

Linear Regression

If regression is used to determine plume stability than the following must be submitted to the department.

- Linear regression using time and COC levels must be inclusive of all applicable chemicals of concern. The slope and R^2 must be clearly explained for each linear regression analysis. If the R^2 is less than 0.7, than multiple regression models including groundwater tables must be calculated.
- If multiple regression is conducted using the independent variable of COC levels and two dependent variables of time and groundwater level, then the multiple regression table must indicate that the slope is decreasing and the R^2 is 0.8 or greater.

Mann-Kendall

Several versions of the Mann-Kendall test exist. The Mann-Kendall analyzes contaminant concentration variability between samples within each monitoring well to determine if concentrations are increasing, decreasing, or have no trend. The department will not accept Mann-Kendall analyses where data from more than 10 or less than 4 groundwater samples (each sample having been analyzed for all applicable chemicals of concern) is used. In addition, the department does not recognize the coefficient of variation (CV) as a determinant of plume stability.

Mann-Whitney

The Mann-Whitney test can also be used to determine plume stability. This is a simplified test that determines if COCs in groundwater are increasing or decreasing. This test ranks concentrations of chemicals of concern in determining plume stability. The department approves the use of this test only when at least two years of quarterly groundwater data are available for use.

Analysis and evaluation of contaminant distribution within the smear zone must be conducted prior to, and independent of, evaluations of the data using the models discussed here. In essence, a plume stability determination has two components: 1) complete site characterization, including particularly the identification and evaluation of contaminant distribution within the smear zone and a determination of how changes in groundwater elevation will effect contaminant concentrations in groundwater and 2) analysis of groundwater monitoring data over time using a statistical model. An independent evaluation of the smear zone is not necessary only when the data used in the model represents conditions associated with both highest and lowest groundwater elevations.

The department also recognizes that the results of statistical analyses are invalid if one or more of the following occurs:

1. The data is suspect or invalid due to sampling and/or laboratory quality control issues, laboratory detection limits, and other errors or deficiencies in sample collection, preservation, or analysis
2. Outlier data are discarded indiscriminately
3. Available data is not representative of seasonal variations in groundwater elevations or is otherwise not representative of true conditions

4. Groundwater data outside of the plume is used in the statistical analysis

Essentially, the results of any statistical analysis or other plume stability determination are valid and reliable only to the extent that the data used in the analysis or determination is valid and reliable.